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ABSTRACT

Competencies considered most desirable for elementary school science in Pennsylvania are identified. These relate to student attitudes, skills (processes), and knowledge (content), considered attainable by the average student by the end of the elementary grades. The items draw from already existing science materials, the Investigative Science in Elementary Education Committee, and reviews of the document by educators. (Author/SA)

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PROPOSED COMPETENCIES FOR ELEMENTARY SCHOOL SCIENCE IN PENNSYLVANIA

Pennsylvania Department of Education 1979

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Proposed Competencies For Elementary School Science In Pennsylvania

Pennsylvania Department Of Education 1979

TABLE OF CONTENTS

SECTION	PAGE
Purpose and Background of Publication	1
Relationships of Competencies to ISEE Program	2
Questions to be Addressed by Users of this Publication	
What are the goals of your Science Program?	4
What is the Status of Your Present Science Program?	4
How Should Minimum Competencies be Determined?	5
Where Do Exceptional Students Fit?	6
How Are Other Subjects Involved?	7
How Should This Publication Be Used?	8
Suggested Student Science Competencies Considered Attainable by the Average Student by Completion of the Elementary Grades	
Attitudes	10
Process	11
Content	13
Additional References	16
Appendix	16
Pennsylvania Goals of Quality Education	18
Acknowledgements	21

PROPOSED COMPETENCIES FOR ELEMENTARY SCHOOL SCIENCE IN PENNSYLVANIA

Purpose and Background of Publication

This publication was written to meet the increasing demand that educational program goals be summarized in student competency statements. While the aims of a desirable elementary school science program were stated in Pennsylvania's science guide, *Investigative Science in Elementary Education,* the competency statements presented here are more easily aligned with present curriculum efforts to establish greater accountability while focusing on skills basic to a student's progress in and out of school.

The question of whether certain student skills presented in a curriculum are suited to success in school or success in life is seldom answered satisfactorily. This document leaves that discussion, and final determination, to those who will use the information presented here. It is important for one to remember, however, that educational programs prepare students for the future, and, therefore, these programs cannot be adequately designed simply by referring to present societal and vocational needs. There is a need to look to the future when new programs are designed.

The items in this publication were prepared from existing printed resources in elementary science, developmental work by the Investigative Science in Elementary Education Committee, and candid reviews of the document by practicing educators. It is the intention of *Proposed Competencies for Elementary School Science* to offer the user a resource of competencies considered most desirable for elementary school science in Pennsylvania. The competency list covers what the developers believe is a satisfactory range of student attitudes, skills (processes) and

knowledge (content). *The statements are written for teachers' and administrators' use, not student use.* Later these competencies will be clustered into interdisciplinary applications which are, ultimately, desirable competencies for success in life.

All of the competencies are considered attainable by the average student by the completion of the elementary grades. But this should not be interpreted to mean that it is a complete list of minimum competencies. Such determinations are, in the opinion of the developers, better placed in the hands of the school district. The competencies here should be considered a resource to those school districts engaged in determining their curriculum and standards. A later section of this publication will pose questions readers should use to guide such efforts.

To summarize, the suggested competencies are a resource available to Pennsylvania schools engaged in determining the science competencies students should possess by the time of completing elementary school. Finally, the competencies are written for students who do not have attenuating learning disabilities.

Relationships of Competencies to ISEE Program

The ISEE (formerly *Science for the Seventies*) has provided direction to Pennsylvania teachers for more than a decade. Presently, ISEE consists of (1) a printed component consisting of the basic guide providing the philosophic basis to inquiry science and 30 ISEE science lessons for primary and intermediate grade teachers; (2) the instructional television component consisting of ten primary and ten intermediate grade instructional television programs, each with accompanying teacher's guides, and inservice ITV programs to orient teachers to ISEE.

As explained, the ISEE program presents the aims and teaching strategies essential to an elementary school science program. This publication was prepared to extend the ISEE effort by providing a list of student competencies considered basic to an elementary science program-competencies that can be used to translate appropriate science activities into contemporary curriculum outcomes.

The questions that need to be answered in this translation and the general considerations that schools must decide form the basis of the next section. This publication offers a framework for the translation, since it suggests the desirable range and emphasis of science instruction in the elementary school.

Questions to be Addressed by Users of this Publication

Any attempt to alter a major segment of the curriculum, such as the elementary science program, requires that the overall goals of that curriculum be studied.

The earliest stages of curriculum development need to include an opportunity for teachers to discuss, act on, and settle differences among themselves and their differing philosophies in order to produce a product flexible enough to be generally acceptable. It is not enough for one or a few individuals to have a sense of where the development is going. Rather, it is more important for all to help develop the curriculum so that all may subsequently feel some ownership of the product.

The curriculum development process needs direction. Unless certain basic questions are studied and resolved, the process and product are likely to be incomplete. Use the following questions

to assist the development, recognizing that the questions do not exhaust all the possible concerns for an elementary science program. Study the additional resources described in the section entitled "Further Assistance" for additional developmental questions and for identifying further developmental activities.

Question 1 - What are the goals of your science program?

If you devise the program you desire, what knowledge, skills, attitudes and understandings will you expect most of your science students to have? Will the students show they are prepared for science careers or hobbies? Will the science skills be most useful in school or out of school? Will all students be expected to reach the same level of competence? Will their achievement be an individual matter, or will that question be set aside? Will the students' competence prepare them for a world of rapid change for the 21st century?

These and similar needs assessment questions that focus on the overall purpose of the program should be answered. In the process instructional strategies for teaching science will need to be discussed, since they have a direct bearing on the nature of the curriculum and facilities.

Question 2 - What is the status of your present science program?

How well does your present science program prepare your students in the knowledge, skills, attitudes and understandings you believe they should have? Are the skills related to out-of-school or in-school success? Is science taught in a manner that encourages thought, observation, critical thinking and a positive attitude? Does your program prepare students for the 21st century? Are girls encouraged as much as boys to study science? Are your science materials adequate? Is your

printed program up to date? What articulation exists from grade to grade, from school to school, and from elementary to secondary schools in your science program? Can you demonstrate accountability in your elementary school science program? Is your pupil achievement acceptable in science? What evidence supports your conclusions?

If there is dissatisfaction with your present program, it should be possible to pinpoint the deficiencies in order to correct them with more appropriate learning experiences. A comparison between the program you desire and your present program obviously can be made only after answering the first question in this section.

Question 3 - How should minimum competencies be determined?

Many educators prefer to ask, "Should minimum competencies for students be determined?" Nevertheless, while resistance is fairly common to this accountability effort, it is receiving increased public support. It would seem wise to use the increased interest in education to shape programs that educators consider desirable. The prospect of having these competencies determined for us by others, even by legislative mandates concerned with narrow educational interests, seems far less desirable. This dilemma makes the choice of examining curriculum and adopting a competency base increasingly easier to accept.

Once accepted, how are minimums to be agreed upon? By the school alone? In combination with the community? What provisions will there be for the retarded, handicapped and all other special students? Will certain competencies be considered basic for all children? Will there be

other competencies to address the broader range of student abilities? Will the percent of mastery be total for basic competencies, then decrease to a lower percent of mastery of more different tasks. What kind of remediation will be provided students who do not attain the mastery level required of them? Will the competencies be identified with specific grade level or extended throughout the elementary school, beginning with competency at a simple level and ending in the complete student competency? Finally, how will the student's competence be evaluated?

The question is complex, the answers critical, and the development process unavoidable. The resource section of this publication has references to provide assistance for this difficult task.

Question 4 - Where do exceptional students fit in?

Aside from the moral obligation to provide each student an appropriate education, laws to guarantee the rights of various students have begun to appear and are setting the pattern for public education. The axiom, "Equal treatment of unequals is the greatest inequality," was never more appropriate than in the education of exceptional children.

Where laws are specific, many decisions are made for the schools. Where there is no legal direction, decisions rest with school districts and their curriculum developers. The only defensible guideline is that each student deserves the activities and standards of competence best suited to that student's capabilities and needs, as determined by educators and parents. Since both parents and educators are vital in this determination, the educational program for exceptional students must be a result of some form of parent - educator interaction.

The competency list in this publication can serve as a reference to assist in this interaction. It is advisable to draw upon the talents of specialists trained in the education of exceptional children when answering the question of how to match a student's needs and abilities. It is safe to conclude, however; that the expectations for exceptional children must be different from those for average students.

Question 5 - How are other subjects involved?

Judging from the amount of difficulty engendered by answering the earlier questions, it may seem quite unnecessary to add this concern as yet another burden. But, instead of representing a burden, the answer really represents a solution to the problem of finding the time to teach science.

It is often said that there are similarities among the various subjects in the skills required of students. Too frequently our subject labels tend to obscure the similarities of skills students need to master these subjects.

At the center of science learning are many basic skills of observation and critical thinking. Examination of the competencies listed reinforces this conclusion and affords the user an opportunity to consider the competencies in light of their possible contributions to student understanding of other skills and subjects – and vice versa. It is not difficult to see the possible contributions to science of social studies, mathematics, or reading skills. Moreover, it is important to be able to demonstrate those relationships so that subjects can be integrated during instruction. It is also important to be able to demonstrate that the subjects reinforce each other and add less to the total instruction time than seems generally apparent.

The other subjects can be involved then by insisting that the competencies be studied from the point of view of those subjects as well as from the point of view of science. Where each subject is taught by a different teacher, these teachers should be part of the development process. Where the teacher is responsible for many subjects, curriculum development must include formal attention to the integration of science learning with the learning of other subjects, and vice versa.

Question 6 - How should this publication be used?

This publication was written to help those individuals involved in a curriculum development or revision. Literature is filled with references regarding procedures for developing curriculum. However, today's circumstances make it imperative that the development includes a broad representation from parents and educators. Any choice of a development process should reflect this trend.

The following points are suggested to the reader using this publication:

- The competencies should be critically examined, but only after the questions in this guide are discussed.

- The list should be regarded as a resource, not a standard or minimum requirement for all students.

- The reader should add competencies , remove competencies, or restate them in words considered more acceptable.

- Ideas for ranking the competencies have already been discussed. A study of the match between what you consider a desirable program and your present program needs to be determined.

As a final observation, it would be disappointing for the authors of this publication to find a school district using the competencies in the same form and number as they appear in the next section.

Suggested Student Science Competencies Considered Attainable

by the Average Student by Completion of the Elementary Grades

ATTITUDES

1. Students will select cause-and-effect relationships to explain contemporary problems.

2. Students will cite their use of scientific processes in personal decision-making.

3. Students will choose to deal with advertisements and other commercial messages objectively, searching for inferences, half-truths and emotional appeal.

4. Students will value science as a way of solving current problems.

5. Students will demonstrate enthusiasm and a positive self-concept toward careers in science.

6. Students will voluntarily seek additional information about science.

7. Students will value science-related reading as a source of enjoyment.

8. Students will regard scientists as persons sensitive to normal human concerns.

9. Students will demonstrate enthusiasm and a positive self-concept toward science learning experiences.

PROCESSES

1. The student will demonstrate competency in observation.

2. The student will observe and describe the properties of objects.

3. The student will demonstrate competency in classifying materials, events, and objects.

4. The student will seek patterns in collection of data.

5. The student will discriminate between description and analysis.

6. The student will discriminate between observation and inference.

7. The student will discriminate between hypothesis and theory.

8. The student will estimate lengths, areas, volumes, and masses in English and metric units and verify by measurement.

9. The student will use Celsius and Fahrenheit thermometers to measure temperatures and will identify common reference points, such as freezing and boiling points of water and body temperature.

10. The student will observe and describe changes which have occurred over a period of time.

11. The student will describe spatial relationships, i.e., relative positions and relative motion.

12. The student will communicate observations and interpretations of ideas, and events.

13. The student will experiment and make predictions.

14. The student will infer one or more causes in explaining an event.

15. The student will draw or modify conclusions based on supporting evidence.

16. The student will avoid reaching premature conclusions about data or evidence encountered.

17. The student will apply the principle of cause and effect in explaining phenomena.

18. The student will attempt to solve problems by asking questions that permit investigation.

19. The student will defend points of view by making use of supporting evidence.

20. The student will construct and interpret graphs and tables.

21. The student will distinguish between cause-and-effect explanations and those based on superstitutions or beliefs that do not permit investigation.

22. The student will observe, record and organize data in a form that is convenient for interpretation.

23. The student will formulate or modify hypotheses to explain events in science.

24. The student will identify and/or control variables in experimentation.

25. The student will use textbooks, reference books, tables of contents, indexes and glossaries to obtain information.

CONTENT

1. The student will describe the forms of energy and discuss transformations from one form to another.

2. The student will define matter and describe in simple terms the atomic nature of all matter.

3. The student will describe the types of energy needed by society, the sources of each kind, and their relative availability.

4. The student will identify the earth's position in the solar system and realize that it is the position from which we view the universe.

5. The student will describe the causes of the seasons, climates, weather, day and night.

6. The student will name and describe the earth's basic surface features and recognize that they have changed over time.

7. The student will differentiate between rocks and minerals and identify common rock and mineral types.

8. The student will describe the earth's time and space relationships on the earth's surface in terms of latitude and longitude.

9. The student will describe the interdependence of all living things, including humans.

10. The student will cite several examples describing how, over long periods of time, species have survived or become extinct according to their chance adaptations to a changing environment.

11. The student will describe several ways in which humans have modified their environment.

12. The student will describe basic ecological relationships.

13. The student will demonstrate a basic knowledge of the human body and the basic principles of personal and family hygiene and nutrition.

14. The student will describe the germ theory of disease and the methods of avoiding and combating infectious diseases.

15. The student will demonstrate a rudimentary knowledge of the classification of plants and animals.

16. The student will cite examples showing that pure scientific research is the basis for modern technology.

17. The student will demonstrate a basic understanding of the world's problems related to population, food production, pollution, and the use of finite resources.

18. The student will describe the effects of science and technology on life style.

19. The student will demonstrate an understanding of the difference between renewable and nonrenewable natural resources.

20. The student will describe the importance of scientific information in the democratic process of political decision-making.

21. The student will demonstrate an understanding of the basic principles of conservation of matter and energy.

22. The student will identify examples of scientific hypotheses and theories as evidence that our interpretation of truth changes and will continue to change as knowledge inceases.

23. The student will cite examples of the life cycles and life processes of living things.

ADDITIONAL REFERENCES

Minimal Performance Objectives for Science Education in Michigan, **Michigan Department of Education**, 1974, Lansing, Michigan 48902.

White, Edwin P., *Linkages - Curriculum Theory - Elementary Science Program Development*, 1978, **University of South Carolina**, Spartanburg, SC 29303.

Clark, Richard C. ed. *Minnesota Essential Learner Outcomes in Science*, **Minnesota Department of Education**, 1977.

Investigative Science in Elementary Education, **Pennsylvania Department of Education**, 1977. (guide, lesson packets, primary and intermediate TV guides).

A Guide for Effecting Instructional Improvement, **Tennessee Department of Education**, Nashville, 1978.

APPENDIX

Pennsylvania Goals of Quality Education

The State Board of Education established the following goals for schools in the Commonwealth. Individuals engaged in study and modification of their elementary school science program should refer to these goals for direction and assistance.

PREAMBLE

The consitution of the Commonwealth of Pennsylvania states, "The General Assembly shall provide for the maintenance and support of a thorough and efficient system of public education to serve the needs of the Commonwealth." This provision mandates a quality education for each child in the Commonwealth.

- The schools have the primary responsibility for the achievement of the Goals of Quality Education as established by the State Board of Education, but they must work in close and continuous cooperation with the family, community and other appropriate social, religious and governmental institutions to insure the highest possible achievement of the goals.

- To foster achievement of a quality education, the school environment should be safe, attractive and orderly, promote a willingness to work for objectives, stimulate a readiness to continue learning throughout life, and encourage the fullest possible educational development of each student.

- To foster achievement of a quality education, the school program should reflect the following goals.

PENNSYLVANIA GOALS OF QUALITY EDUCATION

Adopted by State Board of Education - March 8, 1979

Effective July 1, 1979

COMMUNICATIONS SKILLS

Quality education should help every student acquire communication skills of understanding, speaking, reading and writing.

MATHEMATICS

Quality education should help every student acquire skills in mathematics.

SELF-ESTEEM

Quality education should help every student develop self-understanding and a feeling of self-worth.

ANALYTICAL THINKING

Quality education should help every student develop analytical thinking skills.

UNDERSTANDING OTHERS

Quality education should help every student acquire knowledge of different cultures and an appreciation of the worth of all people.

CITIZENSHIP

Quality education should help every student learn the history of the nation, understand its systems of government and economics and acquire the values and attitudes necessary for responsible citizenship.

ARTS AND THE HUMANITIES

Quality education should help every student acquire knowledge, appreciation and skills in the arts and the humanities.

SCIENCE AND TECHNOLOGY

Quality education should help every student acquire knowledge, understanding and appreciation of science and technology.

WORK

Quality education should help every student acquire the knowledge, skills and attitudes necessary to become a self-supporting member of society.

FAMILY LIVING

Quality education should help every student acquire the knowledge, skills and attitudes necessary for successful personal and family living.

HEALTH

Quality education should help every student acquire knowledge and develop practices necessary to maintain physical and emotional well-being.

ENVIRONMENT

Quality education should help every student acquire the knowledge and attitudes necessary to maintain the quality of life in a balanced environment.

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